THE WATER SKINKS (LACERTILIA: *EULAMPRUS*) OF VICTORIA AND SOUTH AUSTRALIA

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The taxonomy, biology and distribution of the Victorian and South Australian water skinks of the *Eulamprus quoyii* species-complex are reviewed. A lectotype is designated for *Scincus vittatus* Quoy & Gaimard, 1824. Five taxa are recognised: *E. quoyii* Duméril & Bibron from the lower Murray River valley and Mt Lofty Ranges, *E. heatwolei* Wells & Wellington from warm temperate eastern Victoria and the Fleurieu Peninsula, *E. kosciuskoi* Kinghorn from alpine northeastern Victoria and *E. tympanum* Lönnberg & Andersson, the latter with two subspecies, *E. t. tympanum* (including *E. herseyi* Wells & Wellington, 1985), widespread through cool temperate habitats and *E. t. marnieae* ssp. nov., restricted to the stony rises east and north of Lake Corangamite where its survival is threatened by habitat degradation.

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The water skinks form a group of closely related medium sized to moderately large (SVL to 118 mm) Australian lygosomine scincid lizards that inhabit the margins of watercourses throughout the coastal drainage systems of eastern and southeastern Australia (excluding Tasmania). Water skinks are conspicuous, active diurnal heliotherms (Spellerberg 1972b) which readily use water as a refuge, swimming on and under the surface (Daniels & Heatwole 1990).

Traditionally these lizards have been placed in *Sphenomorphus*, either as a subgenus of the catchall *Lygosoma* (Smith 1937) or, following Loveridge (1934) and Mittleman (1952), as a full genus. Recent Australian usage (Cogger 1992, Greer 1989, 1992) has recognised the paraphyletic nature of *Sphenomorphus* (see Greer 1979a, Greer & Parker 1967) by employing the long-disused name *Eulamprus* Fitzinger (type species *quoyii*) for the larger Australian viviparous *'Sphenomorphus'*, including the *E. quoyii* complex. As yet there has not been a rigorous phylogenetic assessment of this assemblage, but Shea & Peterson (1985) and Greer (1989, 1992) discuss some potentially useful characters which indicate that *Eulamprus* is at least more likely to be a natural unit than the much larger and obviously heterogeneous assemblage represented by *Sphenomorphus*, and it is provisionally accepted in this paper.

The first described member of this group was Quoy & Gaimard's (1824) *Scincus vittatus*, the 'Scinque à flancs noirs', from the Sydney region. Duméril & Bibron (1839) redescribed the species using the replacement name *Gongylus (Lygosoma) quoyii*, and as *Lygosoma* or *Sphenomorphus quoyii*, the water skink has become a familiar and relatively well-studied eastern Australian lizard (e.g. King 1964, Veron 1969, Spellerberg 1972a–d, Daniels 1987).

Early workers in Victoria and South Australia (Lucas & Frost 1894, Waite 1929) were familiar with a lizard they referred to as *Lygosoma quoyii,* although specimens from southern Australia do not conform in all respects to the east coastal populations. Two new water skink taxa were described during the early part of this century, *Lygosoma tympanum* from near Melbourne (Lönnberg & Andersson 1913) and *Hinulia quoyii kosciuskoi* from Mt Kosciusko (Kinghorn 1932). Loveridge (1934), in spite of some uncertainty, synonymised *kosciuskoi* with *tympanum*, treating the latter as a southern and highland subspecies of *quoyii*. Worrell (1963) recognised *tympanum* as a full species, distinct from *quoyii*, but did not query the synonymy of *tympanum* and *kosciuskoi*.

Rawlinson (1969) reported that *tympanum* and *kosciuskoi* were distinct species, and that both were distinct from *quoyii*, the three being collectively referred to as the *Sphenomorphus*

[1] Peter Rawlinson died in April 1991. His unpublished studies of type material and his taxonomic insights form the basis of this paper.

quoyii species complex. He also reported a fourth, undescribed member of the complex, referred to as the 'Warm Temperate' form of *S. tympanum*. The data on which Rawlinson's conclusions were based were not presented at the time but these conclusions have become widely used (Cogger *et al.* 1983).

Five species of water skinks are recognised by Cogger (1992). In addition to *Eulamprus quoyii, E. tympanum* and *E. kosciuskoi, E. heatwolei* Wells & Wellington (1984) is applied to New South Wales populations of Rawlinson's 'Warm Temperate' form of *E. tympanum* (Shea & Peterson 1985, Cogger 1992) while *E. leuraensis* Wells & Wellington (1984) is applied to the Blue Mountains population formerly referred to *E. kosciuskoi.*

Shea & Peterson (1985) have summarised data pertinent to New South Wales water skink populations but variation in the southerly parts of their distributions is not well documented and the distributions themselves are not mapped with sufficient resolution in Cogger's books. Much of what is known, including the taxonomic distinctiveness of *tympanum* from *quoyii* and in turn of *heatwolei* from *tympanum* stems from unpublished work of the second author. In addition, a hitherto unreported, morphologically distinctive population of water skinks has been found in central southwestern Victoria. The purpose of this paper is to stabilise the nomenclature, document the distinguishing features and geographic distribution of the four described water skinks in Victoria and South Australia, and to describe the newly discovered Victorian form.

Materials And Methods

The specimens on which this study is based are primarily those of the Museum of Victoria (NMV) and the South Australian Museum (SAMA). Except where indicated, specimen descriptions are based only on Victorian and South Australian specimens. Other Museum abbreviations used here (following Leviton *et al.* 1985) are: AMS, Australian Museum, Sydney; BMNH, Natural History Museum, London; MNHN, Muséum Nationale d'Histoire Naturelle, Paris; NHRM, Naturhistoriska Riksmuseet, Stockholm; NMW, Naturhistorisches Museum, Vienna.

Head shield terminology used in this paper is illustrated in Figure 1. Supraciliaries were counted to the last scale in contact with both the upper palpebrals and the supraoculars. Presuboculars are the scales between the posterior loreal and the subocular supralabial. The postsubocular scale row is formed by the series of scales beginning on the orbital margin of the postsubocular supralabial and running dorsally to the posterior supraciliary. The last infralabial was difficult to distinguish from adjacent scales when the mouth was closed; it was identified here as the last scale contacting the ventral margin of the last supralabial. Scale counts were made using standard criteria (e.g. Greer 1982). Shea & Peterson (1985) employed a different method for counting paravertebral scales than the one used here: they stopped the count at the level of the anterior edge of the hind limb, whereas we followed Greer (1982) in taking the counts posteriorly to the first scale posterior to a line level with the posterior edge of the hind limb held at right angles to the body. This count estimates the number of scales overlying the trunk vertebrae (including the sacrals). Measurements of snout–vent length (SVL), tail length and hind limb length (HLL) were made to the nearest millimetre using a ruler. Head width (HW, measured across temporal jaw muscle bulge) and head length (HL, measured from snout to anterior edge of ear opening) were measured using dial calipers to the nearest 0.1 millimetre. Size at sexual maturity was estimated from smallest female with enlarged ova or male with enlarged testes. Osteological data were obtained primarily from the water skink skeletal collection assembled by S. J. Tilley, now in the collection of the Museum of Victoria.

Systematics

SCINCIDAE Gray, 1825
LYGOSOMINAE Mittleman, 1952

Eulamprus Fitzinger, 1843

A group of lygosomines belonging to the *Sphenomorphus* Group (Greer, 1979b), sharing the derived features of moderately expanded palatal rami of the pterygoids and viviparous reproduction, but lacking the derived character states of other members of this Group. Within this genus, the *E. quoyii* species group shares four derived character states: third pair of chin shields separated by five smaller scales; inguinal fat bodies absent; distal supradigital scales in a single row; subdigital lamellae grooved, divided basally (after Greer 1989).

Other features shared by all species in the complex are as follows. Nasals separated medially. Supranasal and postnasal scales absent.

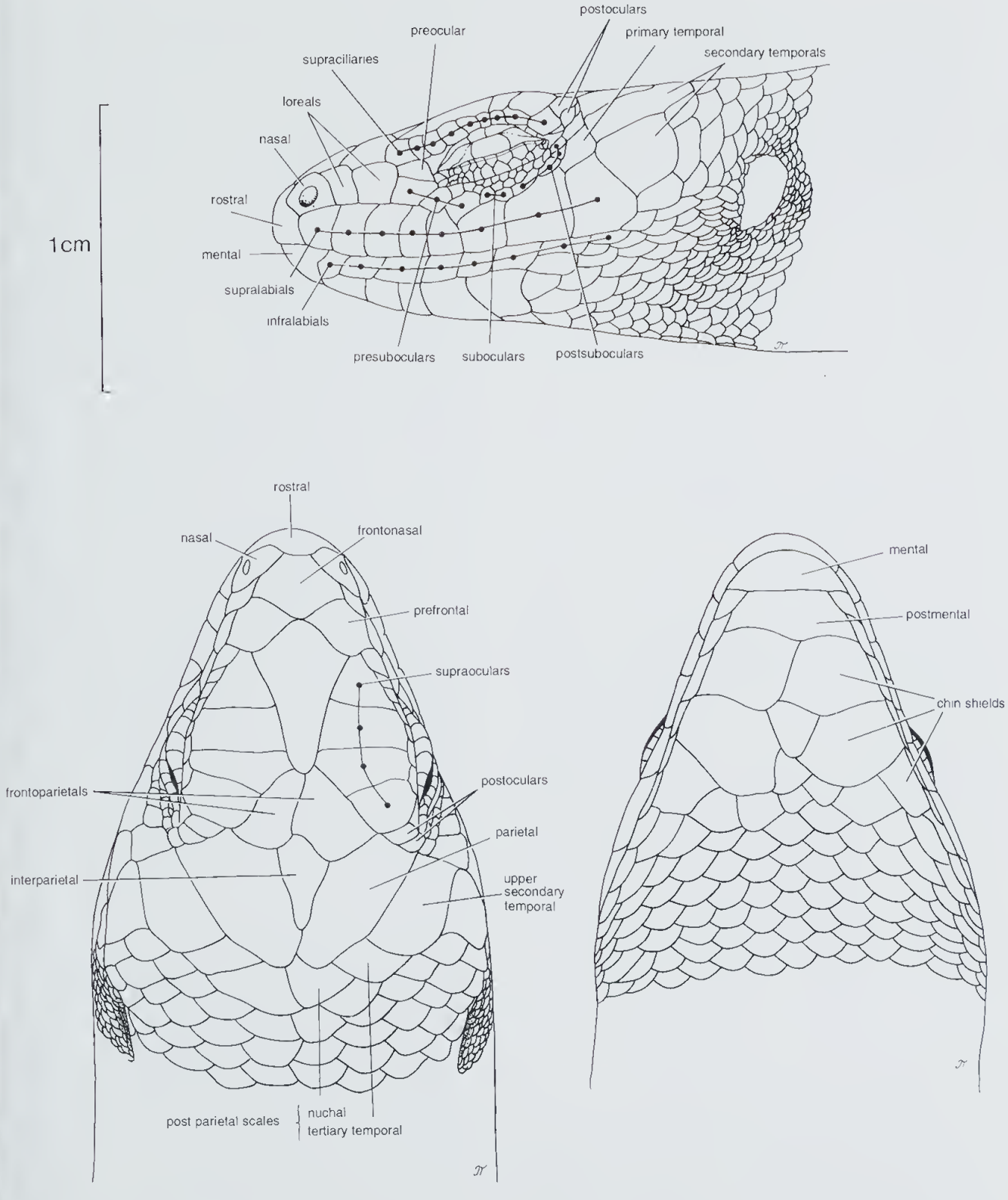

FIGURE 1. Head of a water skink (*Eulamprus t. tympanum*; NMV D50716) showing head shield nomenclature used in this paper.

Two subequal loreals. A single preocular. Lower eyelid scaly. Three presuboculars, the third penetrating downwards in front of the subocular supralabial. Two or three subocular scales. Four supraoculars, the first three (rarely first two) contacting the frontal. Two or three postoculars lie between the posterior supraciliary and the parietal; the dorsalmost and often the largest of these could be regarded as a small fifth supraocular, and its designation as a postocular here is arbitrary, reflecting traditional treatment of these species (e.g. Cogger 1992) as having only four supraoculars. Frontoparietals paired; interparietal distinct. Primary temporal small, variable

intraspecifically, sometimes scarcely distinct from postsubocular scales. Upper secondary temporal longer than deep, contacting lateral margin of parietal scale and bordered below by single lower secondary temporal which is deeper than long; upper temporal may be divided by a vertical suture and lower by a horizontal suture in a minority of specimens. First pair of chin shields in broad median contact; second pair separated by a single scale. Ear opening large, three-quarters the size of the eye, its margin smooth-scaled and without projecting auricular lobules. Median pair of preanals much larger than lateral preanals.

Water skinks show ontogenetic variation in two significant scale characters. In the *Sphenomorphus* Group, each parietal is usually bordered along its posterior margin by a transversely enlarged nuchal (medially) and along its lateral margin by the upper secondary temporal and an additional large scale intercalated between the nuchal and the upper secondary temporal. Most adult water skinks, the alpine species excepted, lack this scale morphology, having instead four or five variably enlarged and often obliquely oriented and asymmetrically arranged scales filling the gap between the upper secondary temporal on each side. Neonates (Fig. 2), however, have the more common lygosomine arrangement of two transversely aligned nuchals. Positive allometric growth of the upper secondary temporal relative to the parietal appears to crowd the post-parietal scales in adults. Water skinks as subadults and adults have smooth body scalation but neonates have all dorsal and lateral body, tail and limb scales keeled, with up to four low keels or pustules on each dorsal scale producing a wavy trailing edge. The scales become smooth and cycloid as the carination is lost at a snout vent length of about 40–45 mm.

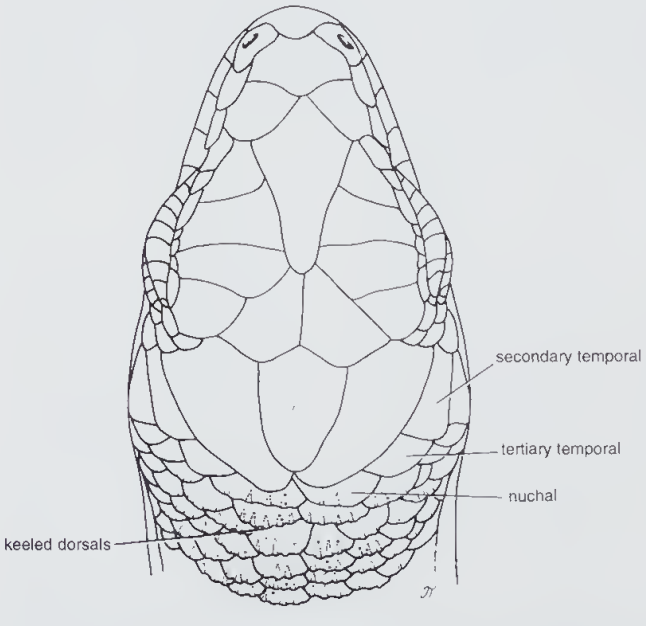

FIGURE 2. Head and forebody of a neonate water skink (*Eulamprus t. tympanum*; NMV D13654). showing the arrangement of post-parietal scales (compare to Fig. 1) and the keeled dorsal body scales present in juveniles but lost early in ontogeny.

Presacral vertebrae 26. Phalangeal formula of manus and pes 2.3.4.5.3 and 2.3.4.5.4 respectively. Postorbital bone present, intraspecifically variable in dorsal exposure from elongate and extending to the supratemporal fenestra to greatly reduced and restricted to the region of thejugal articulation. Supratemporal fenestra large. Ectopterygoid without or with variably developed palatal process which may extend to the palatine, excluding the pterygoid from the infraorbital vacuity. Hemipenis elongate with deep distal bifurcation. Iris of eye black, indistinguishable from pupil in life.

The water skinks show slight sexual dimorphism in proportions, females reaching a slightly larger SVL and males having relatively longer limbs and larger heads. Within species, dimorphism becomes more obvious with increasing body size. Both sexes attain sexual maturity at similar sizes.

Eulamprus quoyii (Duméril & Bibron, 1839)
(Figs 3–4)

Scincus vittatus Quoy & Gaimard, 1824: 178. Lectotype (designated herein): MNHN 7112, Neutral Bay, Port Jackson, New South Wales, F. Péron. (Junior homonym of *Scincus vittatus* [= *Mabuya vittata*] Olivier, 1804).

Gongylus (Lygosoma) quoyii Duméril & Bibron, 1839: 728. Lectotype (Wells & Wellington 1985): MNHN 7113, Neutral Bay, Port Jackson, New South Wales.

Eulamprus quoyii Fitzinger, 1843: 22.

Hinulia quoyii Gray, 1845: 70.

Hinulia gastrosticta Günther, 1875: 11. Lectotype (Wells & Wellington 1985): BMNH 1946.8.15.34 'Queensland', purchased from G. Krefft.

Lygosoma (Hinulia) quoyii Boulenger, 1887: 230.

Sphenomorphus quoyi Barbour, 1914: 204.

Sphenomorphus quoyii quoyii Loveridge, 1934: 349.

Lygosoma (Sphenomorphus) quoyi Smith, 1937: 220.

Eulamprus gastrostictus Wells & Wellington, 1984: 93.

Types

As the oldest available name relating to this group of lizards, Duméril & Bibron's (1839) *Gongylus (Lygosoma) quoyii* must be confidently allocated before other names can be applied. Five syntypes used by Duméril & Bibron are still identifiable in the MNHN collection, four of which are members of the *E. quoyii* species complex, the fifth (7114) being a specimen of the Asian species *Scincella reevesi*. Of the remaining four, two (7112–13) were collected by Péron and are identified by the MNHN as syntypes of *Scincus vittatus* Quoy & Gaimard. Both have a colour pattern which includes well-developed narrow pale dorsolateral lines, matching the figure provided by Quoy & Gaimard (1824) and the description of Duméril & Bibron (1839). The remaining syntypes, 2976 (Port Macquarie, J. Verreaux) and 2977 (Nouvelle Hollande, Lesson et Garnot) are conspecific with 7112 and 7113. Examination of the types thus confirms that the current taxonomy is correct in applying the name *quoyii* to the east-coastal Australian member of the complex. One of Quoy & Gaimard's syntypes, 7113, SVL 105 mm, was designated by Wells & Wellington (1985) as the lectotype of *Gongylus (Lygosoma) quoyii* Duméril & Bibron, 1839. This specimen is not in good condition, the mouth and neck being badly mutilated; however there is no doubt of its specific identity . The other syntype, 7112, is in excellent condition and would have been a better choice. It is hereby designated as the lectotype of *Scincus vittatus* Quoy & Gaimard, 1824.

Four syntypes of Günther's *Hinulia gastrosticta* are in the collection of the Natural History Museum, London (BMNH 1946.8.4.99 and 1946.8.15.34–36) and two more identified as 'Typus' are in the NMW (16656:1–2). All six are conspecific with the lectotype of *Gongylus (Lygosoma) quoyii,* confirming the correctness of Boulenger's (1887) synonymisation of *gastrosticta* with *quoyii.* One of the BMNH syntypes, 1946.8.15.34 (at 101 mm SVL, the largest of the four), was designated as lectotype of *Hinulia gastrosticta* Günther, 1875, by Wells & Wellington (1985) who gave no reason for resurrecting the species from synonymy, nor did they provide any distinguishing features. We here return *gastrosticta* to the synonymy of *quoyii.*

Diagnosis

A large water skink (adults reaching over 110 mm snout–vent) with sharply-defined narrow pale yellow dorsolateral stripes but without a black vertebral stripe.

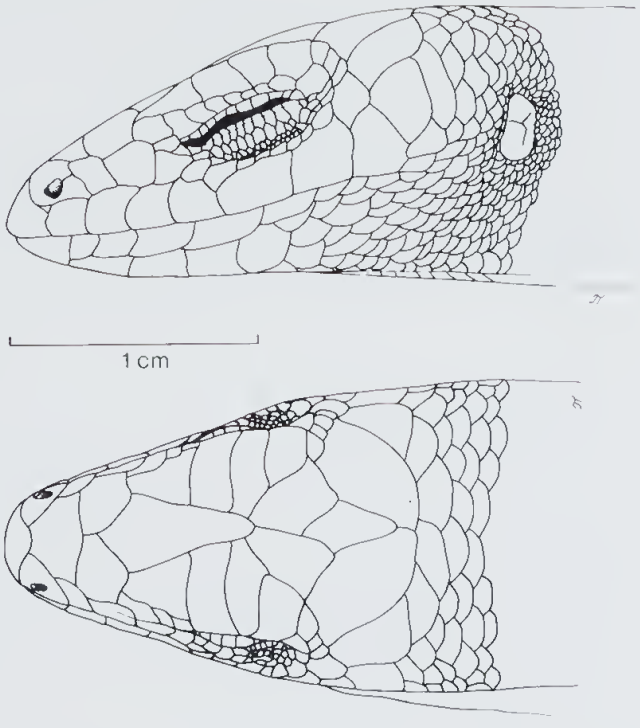

FIGURE 3. Head shields of *Eulamprus quoyii* (SAM R33009).

Description

36–42 ($\bar{x}$ 39.3, n = 36) longitudinal scale rows at midbody. Paravertebral scales 74–88 ($\bar{x}$ 79.7, n = 36), no larger or only slightly broader than adjacent dorsals. Subdigital laellae on fourth toe 24–32 ($\bar{x}$ 27.4, n = 35), most with a median groove and those at the base of the toe divided.

Prefrontals usually broadly contacting (narrowly separated in 4 out of 36). Interparietal elongate, approximately one and a half times as long as wide, but never separating parietals. Each parietal bordered posteriorly by one to three nuchal scales and laterally by the upper secondary temporal. Supraciliaries 9–12 ($\bar{x}$ 9.7, mode 9); first to third or fourth forming decreasing series, next three to five smallest, last two larger, usually penetrating dorsally each side of the fourth supraocular. Supralabials 7–8 (mode 7), fifth or sixth subocular. Infralabials 7–10 (modes 8 and 9), first and second always and third sometimes in contact with (single) postmental.

Premaxillary teeth usually 9 (n = 9); single specimens each with 7 and 8.

Dimensions (of adults, n = 32). SVL 82–112 mm ($\bar{x}$ 94.9 mm). HW 11.2–17.2 mm. HL 17.3–24.9 mm. HL/HW 1.36–1.68, ($\bar{x}$ 1.53). HW/SVL 0.118–0.177 ($\bar{x}$ 0.146). HLL 31–43 mm. HLL/

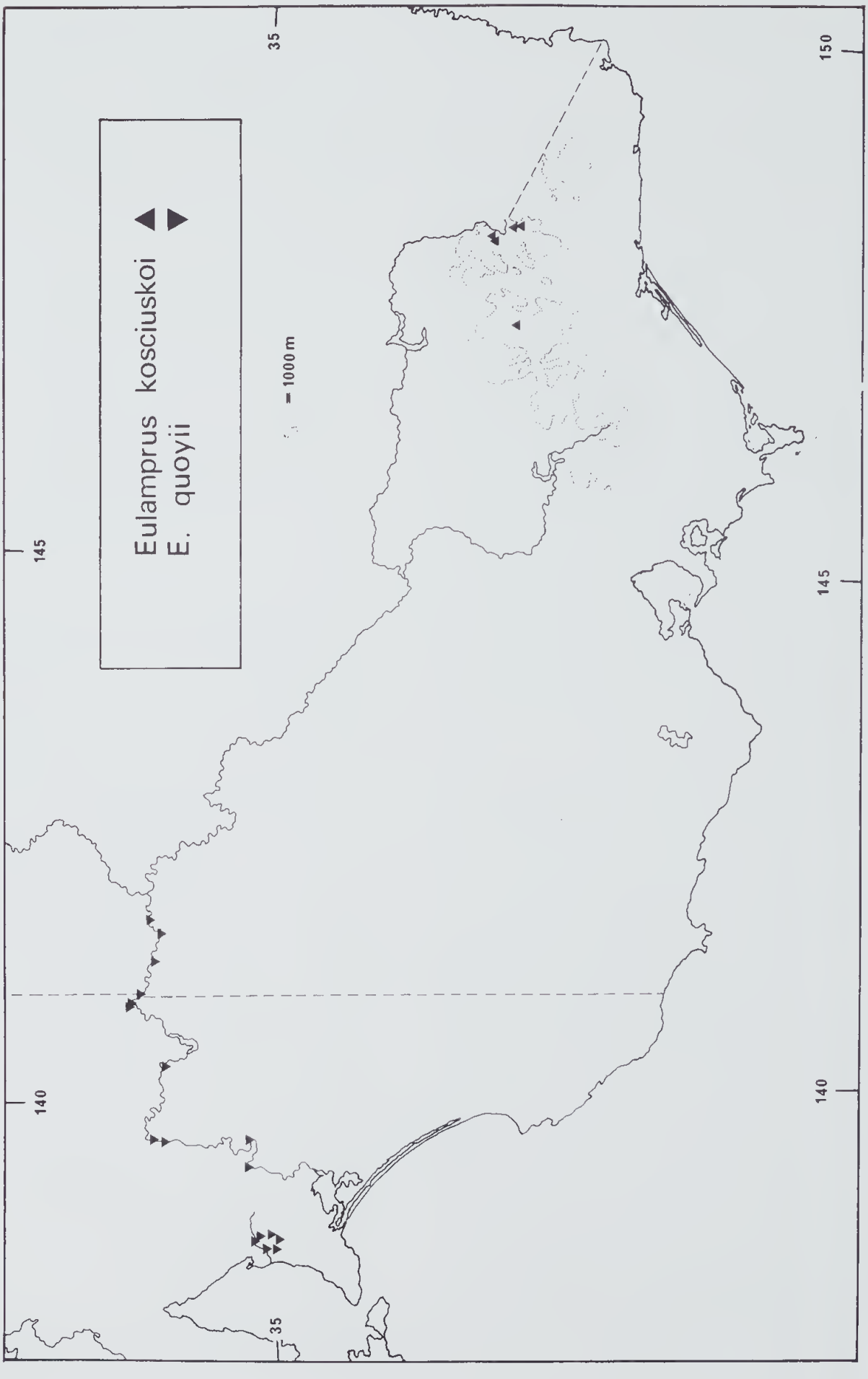

FIGURE 4. Distribution of *Eulamprus quoyii* and *E. kosciuskoi* in Victoria and South Australia.

SVL 0.333–0.464 ($\bar{x}$ 0.401). Tail length/SVL (n = 8) 1.71–1.89 ($\bar{x}$ 1.80).

Colour (in preservative) light to medium brown on the dorsal surface of the head, body, tail and limbs. Dorsum of head and body with a few irregularly scattered fleeks. Limbs brown with irregular black bars. A narrow, well-defined pale yellow dorsolateral stripe runs from the supraciliaries posteriorly to half way along the back, whence it breaks up and fades before reaching the hips. This stripe often margined medially by a narrow black line. Upper lateral zone black, the colour extending anteriorly to the ear opening. Two to three uneven series of pale dots (eaeh covering one to two scales) overlie the blaek. Temporals and posterior supralabials usually obseurely spotted with darker pigment. Lower lateral zone greyish-yellow with black flecks tending to align along seale rows to form weak barring. In adults of both sexes infralabials, chin shields and throat pale to dark grey, spotted with cream, the spotting smaller and arranged in longitudinal lines on the throat. Juveniles and subadults lack this pattern, having instead uniform greyish-yellow throat colouring. Underside yellowish white with fine black dots.

In life the colour is similar to that in preservative.

Distribution

The Murray River from its junetion with the Darling downstream to about Tailem Bend, South Australia (Fig. 4). A disjunct population occurs in the Mt Lofty Ranges. Extralimitally the species occurs along the Darling River and along the east coast of Australia from Cairns, Qld, south to about Jervis Bay, New South Wales.

Ecology

Eulamprus quoyii is only found adjacent to water, living beside permanent lakes, swamps and billabongs or on the banks of perennial streams, typically being observed on logs or rocks emerging from the water's edge. It appears to have eolonised this part of its range by expansion over the Great Divide into the headwaters of the Darling system, and along its course to the Murray. This speeies thus extends into a elimatieally unsuitable (arid) environment by restricting its activity to the mesic riparian corridors (Littlejohn & Rawlinson 1971).

Aspects of the ecology of *E. quoyii* have been examined by Veron (1969), Spellerberg (1972b–d), Daniels (1987) and Daniels & Heatwole (1984, 1990), all studies relating to humid, warm temperate, east coastal populations.

Females ovulate late Oetober–November, with litter size (oviducal eggs) ranging 2–5 ($\bar{x}$ 4.0, n = 5) in Murray Valley and Adelaide Hills specimens. Testes are enlarged between April and August, and regress over spring to a minimum in November–January. The species is viviparous, the young being born during January and February. Mating has been recorded by Veron (1969) as occurring in spring.

Discussion

This species is the type of Fitzinger's genus *Eulamprus*, and Gray's *Hinulia* (Mittleman, 1952), and featured in several early studies of lizard anatomy (Siebenroek, 1892, 1895, Busch 1898). More recently it has been subjected to a variety of anatomical and physiological studies (King 1964, Daniels 1985, Daniels, Heatwole & Oakes 1987, Daniels, Oakes & Heatwole 1987).

Eulamprus quoyii is much the largest of the species in the *E. quoyii* complex, with a mean adult SVL of 95 mm and a maximum of 118 mm (extralimitally), both values being roughly 15 mm greater than the corresponding values for the next largest speeies (*E. heatwolei* and *E. tympanum*). It shares with *E. heatwolei* the most gracile proportions seen in the group, with the longest extremities and slenderest head.

Distribution in the area considered is limited to the Murray River valley and three west-flowing river systems (Torrens, Sturt and Onkaparinga) of the adjacent Mt Lofty watershed. The grey and cream mottled throat pattern is more weakly developed in Mt Lofty populations compared with the Murray Valley populations, suggesting slight differentiation of the two. In this feature, the Mt Lofty populations are more similar to the east coast New South Wales populations in whieh throat patterning is also weakly developed or absent.

Eulamprus tympanum tympanum (Lönnberg & Andersson, 1913)

(Figs 1, 5)

Lygosoma tympanum Lönnberg & Andersson, 1913: 9. Holotype: NHRM 3094 'neighbourhood of Melbourne', Victoria.

Sphenomorplus quoyii tympanum (part) Loveridge, 1934: 350.

Sphenomorplus tympanus Mittleman, 1952: 31.

Sphenomorphus tympanum (part) Worrell, 1963: 53.

Sphenomorphus tympanum Cool Temperate Form, Rawlinson, 1969: 119.

Eulamprus tympanum Wells & Wellington, 1984: 94.

Eulamprus herseyi Wells & Wellington, 1985: 29. Holotype: AMS R111949 (formerly AM Field Series 16791), Dora Dora National Park Proposal Area near Albury, New South Wales.

Type Specimens

The holotype of *Lygosoma tympanum*, NHRM 3094, is in good condition and clearly identifiable as belonging to the 'Cool Temperate Form' of Rawlinson (1969). The anterior margin of the ear opening is pale, the throat and chin are smudged with grey and there is no trace of a pale post-supraciliary streak. Midbody scales are in 37 rows. The specimen is immature, with a SVL of 46 mm. The appearance of the specimen is consistent with the collection data–'said to have been collected in the neighbourhood of Melbourne, July 1911'.

Wells & Wellington (1985) failed to differentiate *Eulamprus herseyi* from its congeners. Their purported diagnosis merely listed a number of scalation and meristic parameters none of which, either individually or collectively, differentiates *E. herseyi* from *E. heatwolei, E. tympanum* or even *E. quoyii*. The only exception is the supposed five supraoculars. The holotype does have five supraoculars on the right side due to an abnormally divided first supraocular but the normal count of four is present on the left side and the specimen is otherwise a typical *E. tympanum*. Wells & Wellington define their genus *Eulamprus* (restricted to the *quoyii* complex) as having four supraoculars, although two of the three species they described, *E. heatwolei* and *E. herseyi*, were said to have five. Possibly the small scale at the posterior end of the supraoculars (see above, p. 187) is responsible for this inconsistency.

Diagnosis

A water skink lacking any trace of longitudinal dorsal striped pattern, with a pale anterior margin to the ear opening, usually 42 or fewer midbody scale rows and without transversely oriented dark dorsal markings.

Description

36–44 ($\bar{x}$ 39.2, n = 116) longitudinal scale rows at midbody. Paravertebral scales 68–89 ($\bar{x}$ 75.3, n = 116), scarcely broader than adjacent dorsals. Subdigital lamellae on fourth toe 18–29 ($\bar{x}$ 22.4, n = 109), most with a median groove and those at the base of the toe divided.

Prefrontals separated (freq. 0.45) or in point to moderately broad contact. Interparietal elongate, approximately twice as long as wide, but usually not separating parietals (frequency of separation 0.11). Each parietal bordered posteriorly by one to three nuchal scales and laterally by the upper secondary temporal. Supraciliaries 8–10 (> 3 > rest. Supralabials 6–9 ($\bar{x}$ 7.1, mode 7, n = 40), fourth, fifth or sixth subocular. Infralabials 6–9 ($\bar{x}$ 7.5, mode 7, n = 40), first and second in contact with (single) postmental.

Premaxillary teeth usually 8 (n = 9), less often 9 (n = 4) or 7 (n = 1).

Dimensions (adults, n = 90). SVL 66–93 mm ($\bar{x}$ 81.7). HW 10.0–14.6 mm. HL 14.7–19.9 mm. HL/HW 1.27–1.59 ($\bar{x}$ 1.43). HW/SVL 0.137–0.168 (x 0.151). HLL 26–36 mm. HLL/SVL 0.311–0.449 ($\bar{x}$ 0.379). Tail length/SVL (n = 26) 1.40–1.83, $\bar{x}$ 1.58.

Colour (in preservative) light to very dark brown on the dorsal surface of the head, body, tail and limbs, immaculate or with few to numerous irregular black flecks. No suggestion of a pale dorsolateral stripe. Tail with dark flecks better developed laterally than dorsally; limbs overlain by heavy black network. Upper lateral zone black, the colour usually fading to brown on the temples. Several uneven series of widely spaced pale dots (each covering only a single scale) overlie the black. A pale horizontal streak runs posteriorly from the dorsal rim of the ear opening and is continuous with the pale anterior edge of ear opening. Lower lateral zone pale grey, lightly dotted with pale yellow and dark grey, less often with weak black barring. Chin and throat light to dark grey in most populations, sometimes with darker smudges. Otway Ranges specimens sometimes with black throats. Remainder of underside yellowish white, sometimes immaculate but usually with black markings which may occur as small dark flecks or as black pigment concentrated along the edges of scale rows, forming thin lines.

In life the general colour is similar in most populations. Ventral colour of Otway Ranges specimens usually bright yellow.

Distribution

The Great Dividing Range, continuous from the New South Wales border to about Ballarat, extending south from the Divide into southern Gippsland. Disjunct populations occur around the Pyrenees, Grampians and Otway Ranges and far southwestern Victoria and southeastern South

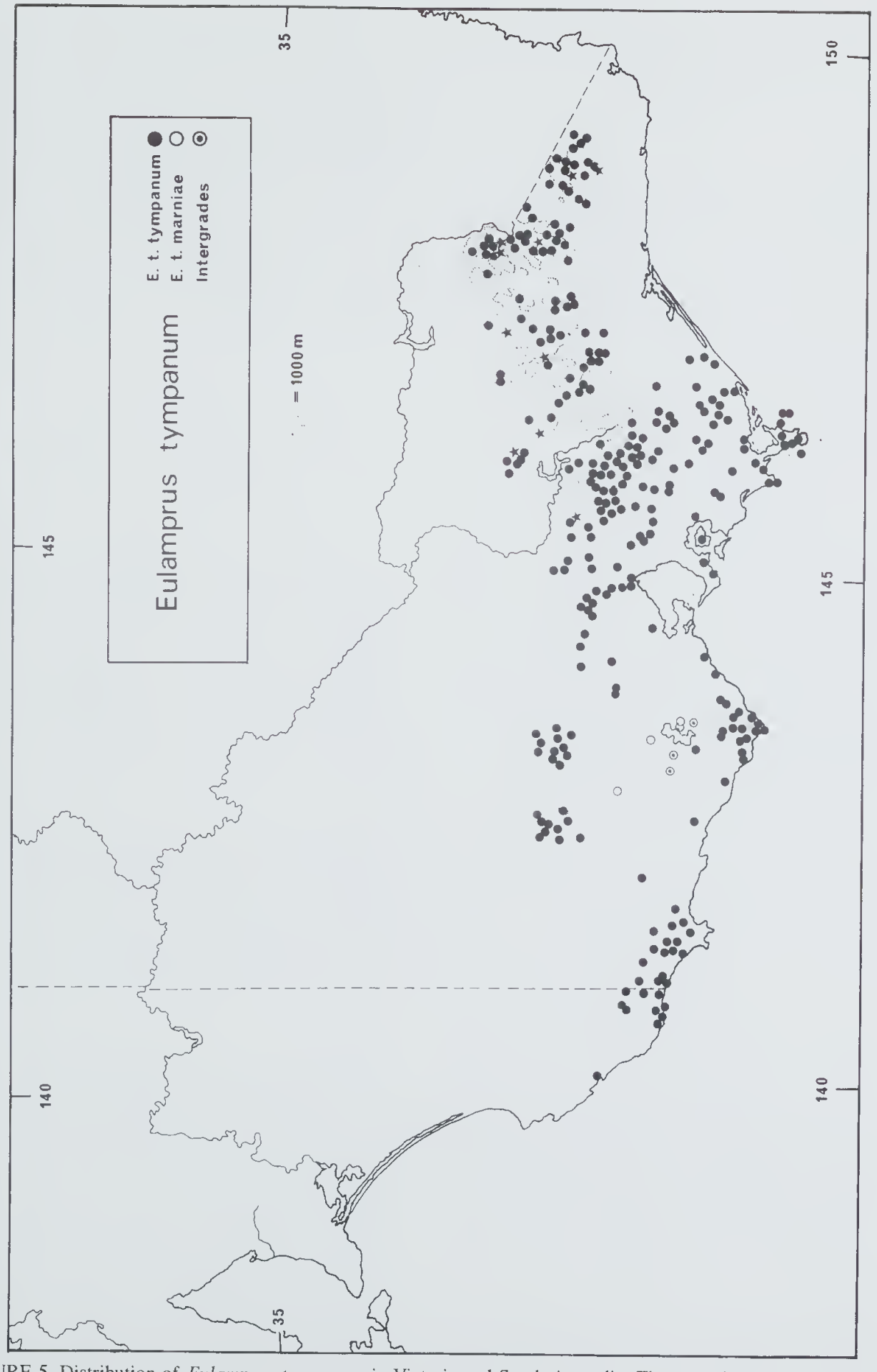

FIGURE 5. Distribution of *Eulamprus tympanum* in Victoria and South Australia. The stars denote localities where *E. heatwolei* and *E. t. tympanum* have been collected in syntopy.

Australia (Fig. 5). Extralimitally the species extends northward along the Great Dividing Range as far as the Blue Mountains, west of Sydney, New South Wales.

Ecology

Aspects of the ecology of *E. t. tympanum* have been covered by Rawlinson (1969, 1971, 1974), Spellerberg (1972b–d), Pengilley (1972), Tilley (1986), Brown (1991) and Schwarzkopf (1992). It is a diurnal and heliothermic skink, restricted to the margins of water courses only in the lower rainfall portions of its range (e.g. the northern and western margins of Melbourne). Over much of cool temperate southeastern Australia, *E. t. tympanum* is a widespread forest-dwelling species. In montane forests in eastern Victoria, the Australian Capital Territory and southern NSW this is one of the most commonly encountered reptile species. Activity is generally centred around rotting fallen logs and stumps which are used as perches for thermoregulation and the cavities of which are used for shelter (Mather 1978, Tilley 1986). Tilley's study demonstrated that the species is probably non-territorial, has low juvenile survivorship but potentially long-lived adults, females living for up to 13 years and males to 11. Brown (1991) found that this species is a generalised invertebrate carnivore, taking only a small proportion of plant matter in its diet.

Females ovulate late October–November, with litter size (oviducal eggs) ranging 2–6 ($\bar{x}$ 4.5, n = 16). Testes are enlarged between April and August, and regress over spring to a minimum in November–January. The species is viviparous, the young being born during January and February. The time of mating has not been recorded. Rawlinson (1974) stated that *E. tympanum* mated in autumn, with overwintering of sperm by females. This latter conclusion was drawn directly from the above mentioned observations of the testicular cycle coupled with the belief that testicular enlargement ought to be correlated with male sexual activity. However, as Greer (1989) noted, both *E. quoyii* (Veron 1969) and *E. heatwolei* (Pengilley 1972) are known to mate in spring even though, like *E. tympanum*, they have a testicular maximum in late autumn–winter. Observational data are needed to establish the time of mating for *E. tympanum*.

Discussion

Eulamprus tympanum is most obviously different from the other water skinks in having a broader head relative to body size than the other species. In body and limb proportions it is intermediate between the gracile *E. quoyii* and *E. heatwolei* and the dumpy *E. kosciuskoi*.

The nominate subspecies shows little geographic variation even though several western populations appear to be isolated from one another. Local trends include larger scales and a greater development of linear black ventral markings in Otway Ranges specimens and longer tails and smaller body scales in Grampians specimens. A general trend is for rock-dwelling, streamside populations to have a greater development of black dorsal flecking than log-dwelling, forest populations.

Eulamprus tympanum marnieae subsp. nov.

(Figs 5–7)

Eulamprus tympanum ssp. nov. Cogger *et al.* 1993: 107.

Types

HOLOTYPE: NMV D52921, adult male, 5.5 km E. of Drecite, Victoria, 38°11'S, 143°34'E, P. A. Rawlinson; P. Robertson and M. Hutchinson, 1 November, 1979.

PARATYPES: 30 specimens, all from Dreeite area. D49377, D49385–92, D52912–20, D52922–52926, D52955–56, D53977–80, D62035 (see appendix for details of localities).

Diagnosis

A water skink distinguished from all other members of the *E. quoyii* species complex by the very small midbody scales (usually in 43 or more rows, versus usually 42 or fewer), the black dorsal markings arranged as short irregular transverse bars, and bold ventral pattern of black longitudinal bars on a bright yellow (in life) background.

Description

40–48 ($\bar{x}$ 44.8, n = 36) longitudinal scale rows at midbody. Paravertebral scales 76–95 ($\bar{x}$ 84.4, n = 36), no larger or only slightly broader than adjacent dorsals. Subdigital lamellae on fourth toe 20–26 ($\bar{x}$ 22.9, n = 36), most with a median groove and those at the base of the toe divided.

Prefrontals separated (freq. 0.47) or in point to moderately broad contact. Interparietal elongate, approximately twice as long as wide, and almost or actually (0.19) separating parietals. Each parietal bordered posteriorly by one to three nuchal scales and laterally by the upper secondary temporal. Supraciliaries 7–9 ($\bar{x}$ 8.0); first to third forming decreasing series, next three smalles, last two larger, usually penetrating dorsally each side

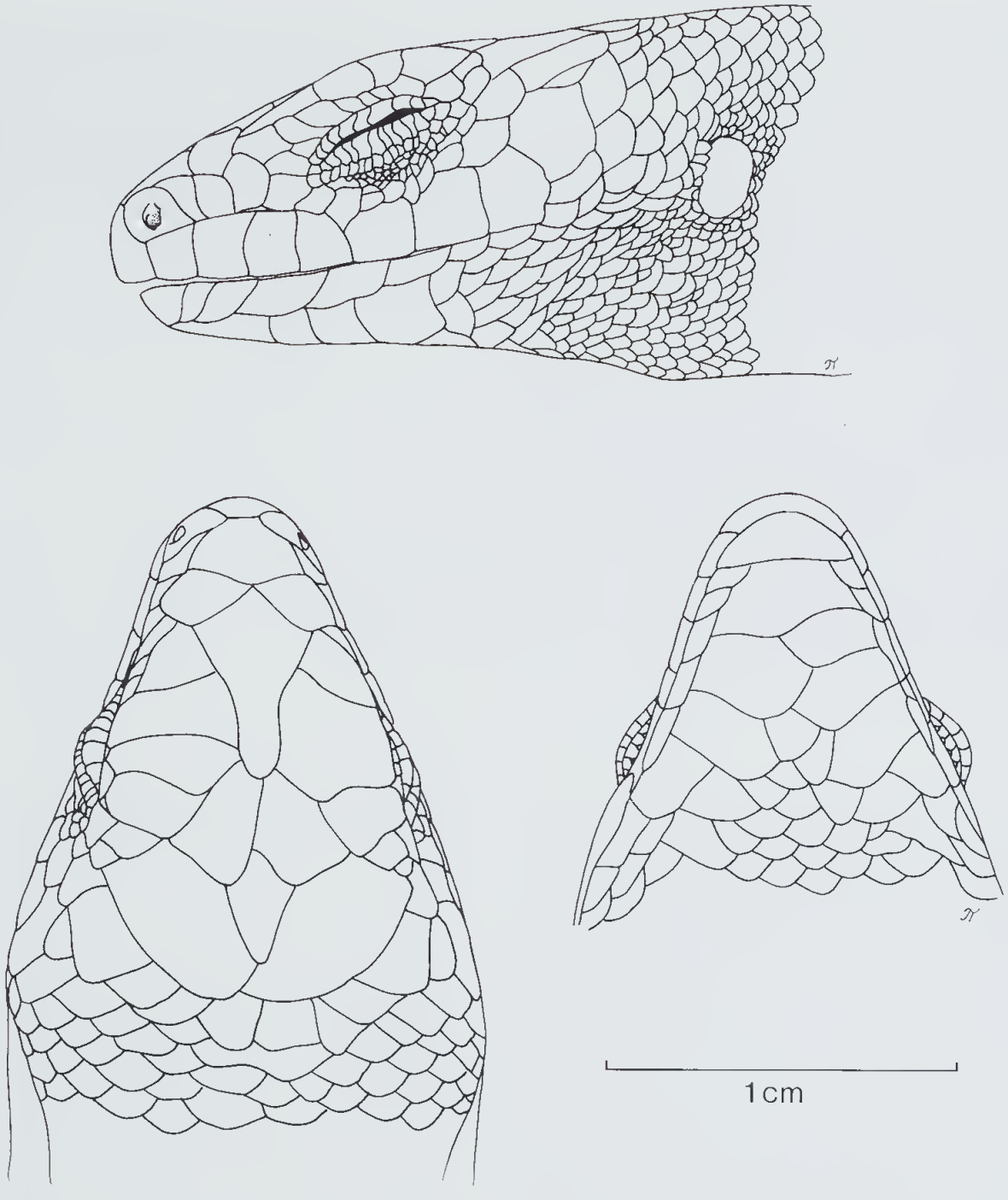

FIGURE 6. Head shields of the holotype of *Eulamprus tympanum marnieae* n. subsp. (NMV D52921).

of the fourth supraocular. Supralabials 6–8, fifth or sixth subocular. Last supralabial sometimes horizontally divided (n = 2) to give the count of six. Infralabials 7–9, first and second in contact with (single) postmental.

Premaxillary teeth 8 (n = 3).

Dimensions (adults, n = 27). SVL 72–97 mm. HW 10.4–15.7 mm. HL 15.3–20.6 mm. HL/HW 1.32–1.50 ($\bar{x}$ 141). HW/SVL 0.132–0.171 ($\bar{x}$ 0.141). HLL 27–36 mm. HLL/SVL 0.323–0.420 ($\bar{x}$ 0.368). Tail length/SVL (n = 6) 1.52–1.72 ($\bar{x}$ 1.63).

Colour (in preservative) light to very dark brown on the dorsal surface of the head, body, tail and limbs, overlain by black markings as follows: head shields with irregularly scattered flecks; back with numerous irregular patches, generally laterally expanded to form transverse bars, some contacting the black upper lateral zone; tail with closely-spaced transverse wavy bars better developed laterally than dorsally; limbs overlain by heavy black network. Upper lateral zone black, the colour extending anteriorly to the eyes. One or two uneven series of widely spaced pale dots

FIGURE 7. Live paratype female of *Eulamprus tympanum marnieae* (NMV D53980) (photo: M. Hutchinson).

(each covering two or three scales) overlie the black, including a whitish temporal spot and a horizontal streak running posteriorly from the dorsal rim of the ear opening and continuous with its pale anterior edge. Dorsal margin of upper lateral black colouring with jagged projections, with a pale spot in the notches between the projections. Lower lateral zone greyish yellow with irregular black barring. Anteriorly to the axilla, the lower lateral zone resolves itself into a midlateral pale stripe. Chin shields white spotted with black. Throat grey-white with large blackish patches laterally which form the ventral margin of the midlateral pale stripe. Underside yellowish white with black pigment forming interrupted longitudinal black patches.

In life the general colour is similar but suffused with yellowish. The dorsal ground colour is frequently bright brassy and the underside of the belly, limbs and tail is bright yellow.

Features of Holotype

Midbody scale rows 47. Paravertebral scales 78. Subdigital lamellae under fourth toe 23. Supralabials 7/8. Infralabials 7/8. Supraciliaries 7/7. Anomalies of scalation include a supernumerary anterior chin shield on the left side and three loreals also on the left side. SVL 80 mm. Tail length 133 mm (1.66 SVL). HLL 33 mm (0.413 SVL). HW 13.0 mm (0.163 SVL). HL 18.0 mm. HL/HW 1.38. Testes regressing.

Etymology

Named for Marnie Lincoln Rawlinson.

Distribution

Rocky outcrops and drystone walls on the northern margins of the basaltic 'stony rises' east and north of Lake Corangamite, southwestern Victoria (Fig. 5). An outlying population occurs beside Lake Bolac to the northwest.

Ecology

A diurnal, evidently heliothermic skink, normally observed perched on a rockpile or fence. Unlike other water skinks this is an extremely shy lizard, fleeing to cover even when a human observer is tens of metres distant and seldom coming into open view while being watched. Like other water skinks, *E. t. marnieae* will dive into water and swim submerged to escape pursuit, but most individuals are observed away from standing water and take refuge in deep gaps in rockpiles. Favoured localities combine remnant arborcal vegetation (notably *Hymenanthera*, Violaceae), deeply fissured basaltic rock piles and permanent or ephemeral swamps. Its habitat in summer can appear very arid compared with the areas

inhabited by its relatives, but in winter the terrain is extensively flooded, with almost all depressions and low-lying areas holding water, and it seems likely that the deep rock piles favoured by this subspecies provide cool and humid refuges even during the dry summer months.

Specimens have been collected between the end of winter and mid-summer and in late autumn. Females ovulate late October–early November, with recorded litter size (oviducal eggs) ranging 2–6 ($\bar{x}$ 4.3, n = 21). Males with enlarged testes have been collected in April and September, with testes regressing in October–November and completely regressed in January. Viviparity is the mode of reproduction in all other water skinks for which mode is known (not confirmed for *E. leuraensis*) so it is highly probable that *E. t. marnieae* is also viviparous. Birth would be expected to occur in January, reinforced by the collection date of the smallest individual in the series, a juvenile (D53977, SVL 39 mm) collected on 24–25 January.

Discussion

The subspecies is known from three populations, each slightly differentiated (see Table 1). Aside from the type population described above, series have been collected from 8 km S of Lismore, Vic., (NMV D36075–084) and from Lake Bolac (D52600–01, D52901–09). The Lismore series is notable for its higher paravertebral counts (up to 98), high frequency of separation of the parietals by the interparietal (8 out of 10) and for a relatively high incidence of division of the last supralabial (4 out of 10). The Lake Bolac specimens are darker, with less yellow pigmentation in life, have the highest midbody scale counts (up to 53), high frequency of separated parietals (7 out of 11) and a common scalation abnormality, fusion of the last two supralabials (5 out of 11).

This taxon is readily distinguished from other water skinks by its small scales and bold dorsal pattern, and the initial conclusion on discovering this form was that it represented a new species. However, subsequent collections suggest that it intergrades with typical *E. tympanum*. North and west, relatively arid conditions provide a barrier between the two; no water skinks have been found in the arc running from between Lake Bolac and the Pyrenees east to about Rokewood and southeast to about Winchelsea. However, to the south and southwest, typical *E. tympanum* is more continuously distributed and specimens from Cororooke (south of Dreeite) and from north of Camperdown (Kariah and Lake Colongulac) are intermediate in colour pattern and scalation between typical *tympanum* and *marnieae* (Table 1).

Such populations have become taxonomically problematic with the recent acceptance of the inadequacy of the old subspecies concept (Collins 1992, Frost *et al.* 1992). The overuse of 'subspecies' to arbitrarily name geographically isolated but undifferentiated populations or to artificially partition continuous or clinal variation has devalued the term, but there remain cases such as the present in which a relatively consistent phenotype confined to a specified geographic area appears to be genetically continuous with adjacent

TABLE 1. Comparison of Victorian populations of *Eulamprus tympanum*. Colour pattern characters scored are: **1**, black transverse dorsal bars present; **2**, black longitudinal ventral bars present; **3**, lateral margins of throat black; **4**, pale lateral flecks cover more than a single scale.

Population (n)	MBSR (x)	PVS (x)	Colour pattern characters 1	2	3	4
E. t. marnieae						
Dreeite area (36)	44.8	84.4	+	+	+	+
8 km S of Lismore (10)	48.4	92.9	+	+	+	+
Lake Bolac (11)	51.1	85.0	+	+	+	+
Intermediate						
Camperdown area (5)	41.0	79.6	–	+	+	–
Cororooke (3)	40.7	77.3	+/–	+	+	–
E. t. tympanum						
Pirron Yallock (2)	39.0	80.0	–	–	–/+	–
Otway Ranges (30)	37.5	73.1	–	–/+	–/+	–
Grampians (30)	40.7	77.0	–	–	–/+	–
Pyrenees–Mt Macedon (26)	39.5	76.8	–	–	–	–
Eastern Victoria (30)	39.3	74.6	–	–	–	–

but phenotypically and geographically discrete populations (Frost & Hillis 1990). In the case of the water skinks reticulate evolution probably occurs at least on the southern margins of the distribution of *marnieae*. The possibility exists of introgression of genes beyond the limits of any putative hybrid zone, suggested by an increase in midbody scale counts south to north moving away from the contact with *tympanum*. To combine the two simply as a binomial *E. tympanum* would bury this most distinctive population, while to recognise *marnieae* as a full species would be to imply an evolutionary independence which is denied by the circumstantial evidence available. Further specimens and biochemical genetic data would illuminate the degree of gene flow currently occurring and would reveal the degree to which the intermediate populations are acting as a bridge or barrier to gene flow; should the latter be established, elevation of *marnieae* to full species status would logically follow. The fact is, however, that such data will be difficult to obtain due to the general difficulty of locating any water skinks in the highly modified intergrade areas.

Eulamprus t. marnieae inhabits a geographically peculiar Victorian landform, technically part of the Newer Volcanics, a region of extensive late Tertiary sheet basalt lava flows, and colloquially known as the 'stony rises'. The 'rises' are basalt ridges and boulder heaps left by the collapse of lava tunnels. The area supports other distinctive herpetofauna, including a small-scaled, speckled form of *Pseudemoia entrecasteauxii* (Hutchinson & Donnellan 1992) and a green morph of the normally brown treefrog, *Litoria ewingii* (Hero *et al.* 1991).

Within its limited geographic range this subspecies occurs only patchily, with only one large colony known. Most of the area in which the species probably once occurred has been extensively modified, with total clearing of vegetation for grazing and continuing demolition of drystone walls and removal of boulders for 'mossy rock' landscape gardening. These processes show no signs of ceasing and the subspecies must be regarded as threatened. The Lismore population was probably wiped out during the rock clearing activities that produced the specimens.

Eulamprus kosciuskoi (Kinghorn, 1932)
(Figs 4, 8)

Lygosoma (Hinulia) quoyii kosciuskoi Kinghorn, 1932: 359. Holotype: AMS R4654, Mt Kosciusko, New South Wales.

Sphenomorphus quoyii tympanum (part) Loveridge, 1934: 350.

Sphenomorphus kosciuskoi Mittleman, 1952: 26.

Sphenomorphus tympanum (part) Worrell, 1963: 53.

Eulamprus kosciuskoi Wells & Wellington, 1984: 93.

Types

The specimens forming the type series, a holotype, AMS R4654, and four paratypes (AMS R558–9, R4832 and R5061), are clearly identifiable as belonging to the southern population. They have a light colour pattern, with weakly marked head and clear light ground colour between the black vertebral and dorsolateral stripes. The dark upper lateral zone does not extend to the ventrolateral area. Midbody scales are in 31–34 rows[2]. The holotype has 34 midbody scale rows, 19 subdigital lamellae and a SVL of 76 mm.

Diagnosis

A small water skink (largest adult 86 mm snout-vent) distinguished from all but *E. leuraensis* by the presence of a black vertebral stripe. Said to differ from *E. leuraensis* by its paler dorsal colouring (including weakly marked head), broader paravertebral stripes and pale-spotted black lateral pattern stopping at the midlateral level rather than extending to the ventrolateral angle of the trunk (Shea & Peterson, 1985).

Description

30–34 ($\bar{x}$ 32.3, n = 37) longitudinal scale rows at midbody. Paravertebral scales 58–68 ($\bar{x}$ 63.6, n = 32), slightly broader than adjacent dorsals. Subdigital lamellae on fourth toe 18–23 ($\bar{x}$ 20.5, n = 32), most with a median groove and those at the base of the toe divided.

Prefrontals moderately separated to broadly contacting (frequency of separated prefrontals 0.38); an azygous 'interprefrontal' sometimes present (frequency 0.16). Interparietal elongate, approximately twice as long as wide, usually (frequency 0.71) separating parietals. Each parietal bordered posteriorly by two moderately

[2] Shea & Peterson (1985) gave the range for this series as 32–35, but obtained the same average across all five, 32.2, as we did.

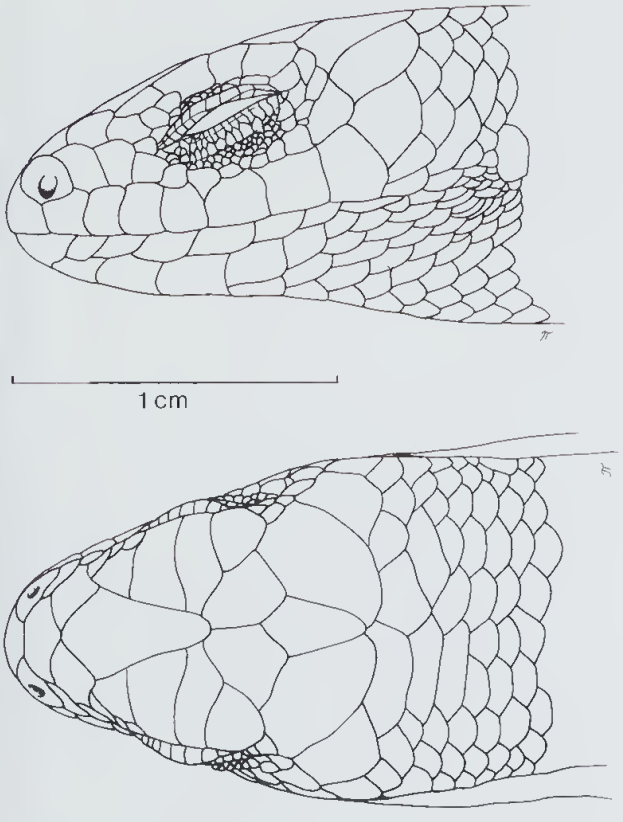

FIGURE 8. Head shields of *Eulamprus kosciuskoi* (NMV D42202).

expanded nuchal scales and laterally by a large upper secondary temporal. Supraciliaries 7–9; size 1 > 2 = last > 3 > rest. Supralabials 6–7 (mode 7), fourth or fifth subocular. Infralabials 7–8 (mode 7), first and second in contact with (single) postmental.

Premaxillary teeth 8 (n = 2) or 9 (n = 2).

Dimensions (of adults, all females, n = 13). SVL 66–74 mm ($\bar{x}$ 70.6). HW 9.2–10.9 mm. HL 13.8–15.4 mm. HL/HW 1.40–159 ($\bar{x}$ 1.49). HW/SVL 0.129–0.152 ($\bar{x}$ 0.140). HLL/SVL 0.292–0.361 ($\bar{x}$ 0.326). Tail length/SVL (for individuals > 50 mm SVL, n = 8) 1.07–1.25 ($\bar{x}$ 1.17).

Colour (in preservative) light brown on the dorsal surface of the head, body, tail and limbs. Back with a black vertebral stripe running from the nape to the base of the tail. A narrow yellow dorsolateral stripe runs from the supraciliary region to the base of the tail, becoming less brightly coloured. This stripe edged medially by a wider black stripe. Black upper lateral zone, commencing at the ear and breaking up on the tail, with three to four series of yellowish dashes or dots, tending to align longitudinally on adjacent scale pairs. A horizontal streak runs posteriorly from the top of the ear opening and is continuous with the pale anterior margin of the ear. Tail with regularly spaced blackish lateral blotches. Limbs brown mottled with black. Lower lateral zone greyish with black spots, the pattern continuing across the belly. Infralabials, chin, throat and remainder of underside greyish white with scattered black spots.

In life the general colour is similar but overlain by a yellow–green opalescent gloss.

Distribution

Davies Plains–Mt Cobberras area and the Bogong High Plains, Victoria (Fig. 4). The southern, typical populations of this species are confined to the Snowy Mountains of New South Wales and the adjacent alpine areas of Victoria. A second morphologically distinct group of populations occurs in the Barrington Tops region and on the New England Plateau (Shea & Peterson, 1985).

Ecology

The Snowy Mountains–Victorian High Plains populations of this species have a restricted habitat, being found only in subalpine to alpine bogs and sluggish creek margins, the habitats being characterised by being perennially wet, cool and densely vegetated at ground level. Coventry & Robertson (1980) and Mansergh (1982) briefly describe the habitat of this species at Davies Plains and Mt Cope, respectively.

We have no explanation for the absence of males in this sample, and their under-representation in the samples of *E. heatwolei* and *E. tympanum*. Certainly those females that are pregnant are more catchable than non-pregnant females or males, but excluding pregnant females still leaves a deficiency of males. Further study of wild populations could determine whether there is a sex ratio bias against males, or whether behavioural attributes of the sexes make males harder to collect.

Most specimens have been collected during late January, at which time about half of the females (5) have full term young, while the rest (6) contain no young or enlarged ova. A single adult female collected in December contains advanced embryos, while a single adult female collected in February is non-breeding. At present it is not possible to say whether the females without young in January had just given birth or had not bred that year, but this would be worth exploring in view of the fact that females of the Tasmanian alpine skinks (*Niveoscincus*) only breed every second year (Greer, 1982, Hutchinson *et al.* 1989). Litter size is 2–4 ($\bar{x}$ 3.2).

Discussion

Shea & Peterson (1985) noted that the topotypic (Mt Kosciusko area) population of *E. kosciuskoi* is more similar to *E. leuraensis* than is the New England population, suggesting some intermediacy, but maintained the specific distinctness of the latter taxon. In fact, where one draws the line between populations depends upon the character chosen; if colour pattern, then most Snowy Mountain–Victorian and New England *E. kosciuskoi* are more similar to each other than either is to *E. leuraensis,* while if limb proportions and head and body scalation are considered, then the new England *E. kosciuskoi* stand apart. Moreover, the more melanised individuals in the Victorian sample approach the description of *E. leuraensis* in that the head is heavily black-flecked, the laterodorsal black stripes are broader and leave little dorsal ground colour showing and the midlateral pattern extends ventrally to the lower lateral area. It appears therefore that no absolute distinctions separate any populations formerly referred to *E. kosciuskoi.* It is evident from comparison with other water skink populations that degree of dorsal melanisation can be labile in water skinks and that isolated populations can undergo shifts in scale count frequencies. The situation of *E. tympanum* discussed above also shows that much greater qualitative differences in colour pattern and scale size are not necessarily indicative of independently evolving entities (species).

Allopatric populations are a problematic group, even if one discards the increasingly unpopular biological species concept (BSC, e.g. Frost & Hillis 1990). Recent debate on the North American fauna (Collins 1991, 1992, Montanucci 1992, Van Devender *et al.* 1992, Frost *et al.* 1992) highlights the differing views that can exist concerning populations which until recently most authors would have identified as subspecies, more for convenience than as a positive expression of the degree of historical independence. Further consideration of the status of *E. leuraensis* is beyond the scope of this study, but the appropriate taxonomic treatment for the alpine water skink populations could stand further analysis.

Eulamprus heatwolei Wells & Wellington, 1984

(Figs 9, 10)

Sphenomorphus tympanum Warm Temperate Form, Rawlinson, 1969: 119.

Eulamprus heatwolei Wells & Wellington, 1984: 93. Holotype: AMS R116967 (formerly AM Field Series 27987), Macquarie Rivulet, just east of Robertson, New South Wales, R. W. Wells, 20 October, 1982.

Sphenomorphus heatwolei Shea & Peterson, 1985: p. 144.

Type Specimen

The holotype of *Eulamprus heatwolei*, AMS R116967, is in moderate condition, with the tail almost broken and is clearly identifiable as belonging the 'Warm Temperate Form' of Rawlinson (1969). Wells & Wellington (1984) purported to diagnose the species by listing the attributes of the holotype, but only aspects of the colour pattern description are unique to *heatwolei.* Our observations on the holotype disagree with those of Wells and Wellington (in square brackets) in several significant respects. Midbody scale rows 40 [38]. Tail regenerated, so subcaudal count [73] irrelevant. Supraoculars 4 [5]; first supraocular on left fragmented, with two abnormal small scales contiguous with the supraciliary row. Postnasal scales absent [said to be present]. One [2] preocular, if the lower of two antorbital scales is regarded, as here, as the first presubocular. Supraciliaries 10/9 [6]. Adpressed limbs strongly overlap, the fourth toe of the hind foot reaching about the level of the elbow [adpressed limbs just fail to meet]. Other important points not mentioned in the type description are throat colouring, the chin shields being heavily edged with black and the throat grey with four irregular blackish longitudinal bars, and size, the snout–vent length being 71 mm.

Diagnosis

A water skink lacking longitudinal dorsal stripes, most similar to *E. tympanum,* but differing in its longer appendages, pale post-supraciliary streak, black anterior edge of the tympanic opening and immaculate venter (bright yellow in life).

Description

36–44 ($\bar{x}$ 39.9, n = 73) longitudinal scale rows at midbody. Paravertebral scales 69–89 ($\bar{x}$ 77.5, n = 73), scarcely or not broader than adjacent dorsals. Subdigital lamellae on fourth toe 23–29 ($\bar{x}$ 25.1, n = 73), most with a median groove and those at the base of the toe divided.

Prefrontals in point to broad contact (freq. = 0.32). Interparietal elongate, approximately twice as long as wide, but seldom separating parietals

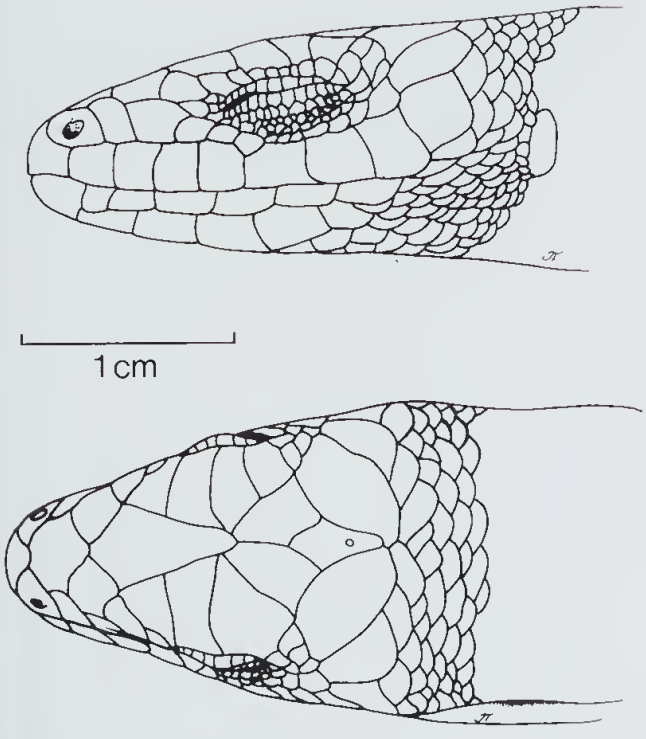

FIGURE 9. Head shields of *Eulamprus heatwolei* (SAM R38610).

(3 out of 73 scored). Each parietal bordered posteriorly by one to three nuchal scales and laterally by the upper secondary temporal. Supraciliaries 7–11 ($\bar{x}$ 9.1, mode 9); size 1 > 2 = last > 3 > rest. Supralabials 7–9 (mode 7), fifth or sixth subocular. Infralabials 6–9 (mode 8), first and second in contact with (single) postmental.

Premaxillary teeth usually 9 (n = 8), less often 8 (n = 3).

Dimensions (of adults, n = 47). SVL 74–101 ($\bar{x}$ 84.3). HW 10.1–14.0 mm. HL 16.3–20.7 mm. HL/HW 1.42–168 ($\bar{x}$ 1.51). HW/SVL 0.126–0.162 ($\bar{x}$ 0.143). HLL 30–36 mm. HLL/SVL 0.327–0.439 ($\bar{x}$ 0.379). Tail length/SVL (n = 13) 1.58–1.92 ($\bar{x}$ 1.76).

Colour (in preservative) light to very dark brown on the dorsal surfacc of the head, body, tail and limbs. Head shields with irregular black flecks. A paler brown streak, suggesting the start of a pale dorsolateral stripe, runs posteriorly from the supraciliary region to the neck. Back usually with numerous irregular black flecks; immaculate in very few specimens (those from the Murray River, both Victorian and South Australian). Tail with black, closely-spaced wavy bars laterally; limbs overlain by wavy black bars. Upper lateral zone black, the colour extending over the temporals and eye to the loreals. Several uneven series of pale dots (each covering only a single scale) overly the black. A pale horizontal streak runs posteriorly from the dorsal rim of the ear opening; anterior edge of ear opening black. Lower lateral zone greyish with black scales forming irregular vertical or backward-sloping bars or a black reticulum. Chin and throat white, most populations with black edges on chin shields and elongate black blotches on the throat. Remainder of underside yellowish white, immaculate.

In life the general colour is similar but suffused with yellowish. The dorsal ground colour is frequently brassy and the underside of the belly, limbs and tail is bright yellow..

Distribution

Eastern Victoria, west to about the Goulburn River (Fig. 10). Absent from higher elevations along the Great Dividing Range. An isolated record from Great Western (Victoria) and a disjunct group of populations on the lower Fleurieu Peninsula, South Australia, from Deep Creek to the northern shore of Lake Alexandrina. Extralimital in eastern New South Wales north to the New England plateau.

Ecology

This species is very similar in habits to *E. quoyii,* being mostly restricted to creek margins. Most populations of this species favour rocky substrates, but the species does occur along muddy river banks, notably the Murray in north–central Victoria and at its mouth in South Australia. Its reproductive characteristics appear similar to those of *E. quoyii*, with similar ovarian and testicular cycles. Litter size among the specimens examined ranged 2–4 ($\bar{x}$ 3.3, n = 9).

The distributions of *E. heatwolei* and *E. t. tympanum* are complementary to a remarkable degree; although the distributions abut and interdigitate throughout eastern Victoria there are few places (a total of ten) where specimens have been collected in syntopy (indicated by stars in Figs. 5 and 10). Syntopy generally occurs along stream valleys where *E. heatwolei* can extend along the warm valley floor to contact *E. tympanum* populations inhabiting the cooler, elevated valley slopes. In East Gippsland, the aspect of a section of stream channel can determine the species present, with north facing slopes occupied by *E. heatwolei* while south-facing slopes are occupied by *E. t. tympanum.* Meandering watercourses may show an alternation of species (A. J. Coventry, pers. comm.) depending on the degree of shading. No

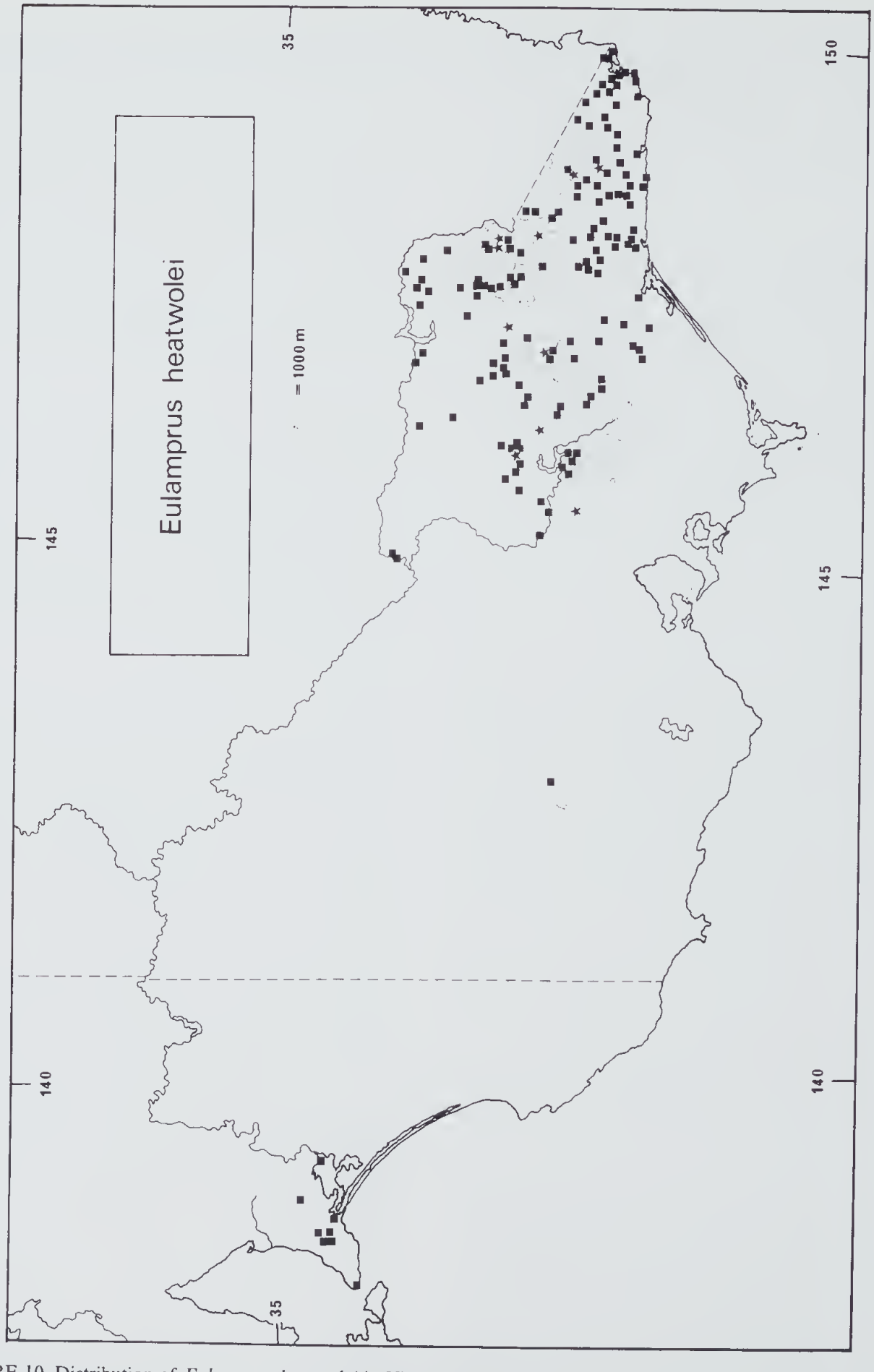

FIGURE 10. Distribution of *Eulamprus heatwolei* in Victoria and South Australia. The stars denote localities where *E. heatwolei* and *E. t. tympanum* have been collected in syntopy.

studies have yet been directed to determining the degree to which competition or the documented physiological differences (Spellerberg, 1972b,c) determine range limits in these two species.

Discussion

The type locality of *E. heatwolei,* Robertson, New South Wales, is adjacent to this region so that as yet the species is not certainly recorded from other parts of Australia. Cogger (1992) mapped the species as far south as the New South Wales-Victoria border. For many years workers have used Rawlinson's informal taxonomy to distinguish two species level taxa, the 'Cool Temperate' and 'Warm Temperate' forms of *Eulamprus* (as *Sphenomorphus*) *tympanum* (e.g. Spellerberg 1972b–d, Rawlinson 1974, Jenkins & Bartell 1980). The forms have been distinguished mainly on ventral colouring, as well as dorsal head colour pattern and proportions. Examination of the holotype of *E. heatwolei* and other New South Wales specimens shows that they do not differ from the Victorian 'Warm Temperate Form'. Accordingly, the concept of *E. heatwolei* is expanded to include these populations.

Shea & Peterson (1985) listed variation within this species based on Blue Mountains area specimens only. Their data are similar to ours, with slightly higher midbody scale counts ($\bar{x}$ 40.8) and maximum snout–vent length a little less (92 mm).

South Australian populations of this species are geographically remote from the main eastern Australian populations, and are restricted to only a few known sites. The terminus of the Murray River on the northern margin of Lake Alexandrina supports a colony living immediately adjacent to the water on eroding banks next to cleared grazing land. On the lower Fleurieu Peninsula *E. heatwolei* is confined to a few perennial rocky streams which retain some streamside vegetation. In spite of their isolation, these populations differ little from the continuous populations of eastern Victoria and New South Wales. Body scales are small, with midbody scale counts restricted to the upper half of the total range of variation seen in the species as a whole (midbody scale rows 40–44, $\bar{x}$ 41.5 in South Australia), and higher paravertebral counts (74–89, $\bar{x}$ 80.2, versus 69–82, $\bar{x}$ 76.4 in Victoria). The South Australian colonies appear vulnerable to habitat changes. At Lake Alexandrina changes in Murray River flow, either decreases leading to drying out or increases causing erosion of the banks, may destroy local populations. In the rocky streams of the Fleurieu Peninsula, modification of the banks, with either clearing of the vegetation or silt build-up reducing exposed rocks, is likely to be deleterious.

A Key To The *Eulamprus* Of Victoria And South Australia

1 – Pale yellow dorsolateral line runs from behind the eye to at least the posterior one-third of the trunk 2

– No pale yellow dorsolateral line 3

2 – A black vertebral stripe..... *E. kosciuskoi*

– No black vertebral stripe..... *E. quoyii*

3 – Dark dorsal markings arranged as irregular transverse bars; usually more than 42 midbody scale rows ..... *E. t. marnieae*

– Dark dorsal markings (if present) in the form of small black flecks; usually fewer than 43 midbody scale rows 4

4 – Anterior margin of ear opening black; belly in life immaculate bright yellow, most intense under chest and groin; throat white with black patches ..... *E. heatwolei*

– Anterior margin of ear opening cream; belly in life pale yellow to greenish yellow (bright yellow striped with black in some Otway Ranges specimens) with or without black flecks; throat light to dark grey, with or without darker grey smudges..... ..... *E. t. tympanum*

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Appendix

Specimens examined.

Eulamprus heatwolei.

New South Wales: AMS R116967, Macquarie Rivulet, just E of Robertson (Holotype).

Victoria: MV D552, Great Western, 37°09'S 142°52'E; D2286, Wangaratta, 36°21'S 146°19'E; D34392, 5.6 km N.E. of Wodonga, 36°10'S 146°51'E; D34488, Nug Nug, Ovens River, 1.6 km. W. of Myrtleford, 36°39'S 146°43'E; D 34541–48, Poddys Creek, 24.1 km. W. of Cann River, 37°36'S 148°54'E; D34549, 14.5 km N. of Nariel, 36°18'S 147°50'E; D 34550, Still Creek, 30.6 km S.E. of Eildon, 37°25'S 146°09'E; D34551, 12.9 km S. of Sardine Creek, 37°31'S 148°40'E; D34552, 16 km E. of Orbost, 37°41'S 148°35'E; D34553, 24.1 km N. of Orbost, 37°34'S 148°34'E; D34554, Snowy River, Tulloch Ard Gorge, 37°16'S 148°19'E; D34560–62, Goulburn River, 16 km S.E. of Seymour, 37°08'S 145°16'E; D36839, Lake Tali Karng, 37°33'S 146°47'E; D36841, 2nd last crossing of Wellington River, Lake Tali Karng Track; D36842, 9.7 km N. of Culloden on Dargo River, 37°41'S 147°08'E; D36843, Wangareta [=Wangaratta], 36°22'S 146°19'E; D36844–45, 14.5 km N. of Stockdale, 37°40'S 147°11'E; D36846–48, 16.1 km N.N.W. of Stockdale, 37°39'S 147°06'E; D36849–53, 5.6 km E. of Wodonga, 36°09'S 146°52'E; D36854–55, 19.3 km S.W. of Walwa, 36°05'S 147°34'E; D36856, 0.4 km. E. of Genoa, 37°28'S 149°36'E; D42564–86, Sheepwash Lagoon, 37°10'S 145°32'E; D56624, Seven Creeks, Goorum Falls, 36°54'S 145°35'E; D57154, Two Mile Creek, 13.4 km N.N.W. of Picolo, 35°59'S 144°56'E; D57164, Ovens River, Naughtons Bend, 14.3 km N.W. of Peechelba, 36°06'S 146°08'E.

South Australia: MV D34467–68, 3.2 km. E. of Myponga; D34487, D36880, Hindmarsh Falls, 35°27'S 138°35'E; D34555–56, D34559, Angas River, Strathalbyn, 35°16'S 138°54'E; D34558, Currency Creek, 35°27'S 138° 46'E. SAMA R2878, Tapanappa Rocks, 35°38'S 138° 15'E; R3018, Deep Creek, 35°36'S 138°15'E; R13436A–B, Withers Creek, tributary of Deep Creek, 35°38'S 138°15'; R17074, 1 km S of Mount Compass, 35°22'S 138°38'E; R18572–73, Tower of Babel, Inman Valley, 35°28'S 138°33'E; R24077, Lake Alexandrina [north shore], 35°24'S 139°19'E; R38557, Hindmarsh Falls, 35°27'S 138°35'E; R38610–12, North shore of Lake Alexandrina at exit of Murray River, Nalpa Stn, 35° 24'S 139° 20'E.

Eulamprus kosciuskoi.

New South Wales: AMS R558–59, R4654, R5061, Mt Kosciusko (Types of *Lygosoma (Hinulia) quoyii kosciuskoi*)

Victoria: MV D42060, Charlies Creek, Davies Plains Track, 36°17'S 147°59'E; D42075, Charlies Creek, Davies Plains Track, 36°17'S 147°59'E; D42110, Charlies Creek, Daveys Plain Track, 36°17'S 147°59'E; D42201–02, Charlies Creek, Davies Plains Track, 36°17'S 147°59'E; D42203, King Plain, Davies Plains Track, 36°39'S 148°04'E; D 47513–15, Davies Plains, 36°17'S 147°59'E; D47539–49, D47589–90, D47654–59, Davies Plains, 36°17'S 147°59'E; D48557, The Playgrounds, Mt. Cobberras, 36°52'S 148°09'E; D55111, Mt. Cope area, 36°56'S 147°17'E; D55630, Rocky Plains, 36°56'S 148°10'E; D56465–66, 1 km E. of Mt. Cope, 36°56'S 147°17'E; D59849, The Playgrounds, Mt. Cobberras, 36°52'S 148°09'E.

Other: AMS R4832, no data ('Tonga', in error).

Eulamprus quoyii.

New South Wales: MNHN 2976, Port Macquarie; 7112–3, Neutral Bay, Port Jackson. (Types of *Gongylus (Lygosoma) quoyii).*

Victoria: MV D1352, D1372, No other data; D13871, Lindsay River, Berribee Station, 34°0'S 141°0'E; D34326–31, Murray River, 6.4 km W. of Lock No.9; D39078–79, Potterwalkalgee Creek, 34°08'S 141°23'E; D39080–81, Murray River & Potwatagee [=Potterwalkalgee] Creek junction, 34°08'S 141°23'E; D39085, Potterwalkalgee Creek, 34°08'S 141°23'E; D56882–83, Potterwalkalgee Creek, 5 km E. of Neds Station corner, 34°08'S 141°23'E; D61906, Dedman Creek, 13 km W. of Horseshoe Lagoon, Wallpolla Island, 34°08'S 141°42'E.

South Australia: MV D5297, Purnong, 34°51'S 139°38'E; D34282–83, Kingston [on Murray]; D34284–89, Torrens River Gorge, 34°52'S 138°46'E; D 39070–71, Cattambal, Torrens River Gorge. SAMA R2393A–B, Sturt River, Eden, 35°01'S 138°36'E; R2874, Mylor, 35°03'S 138°46'E; R2889, Bridgewater, 35°00'S 138°46'E; R11177, Torrens Gorge, 34°53'S 138°44'E; R13481, just N of Sinclair Flat, River Murray, 34°15'S 139°38'E; R13482, Waterfall Gully, 34°57'S 138°41'E; R18519, Glenforslan Ranch, 34°15'S 139°39'E; R22306–07, Sturt Creek, FlagstaffHill area, 35°02'S 138°32'E; R33009, Monoman Creek, Chowilla, 33°56'35"S 140°52'45"E; R33350, Clarendon, 35°07'S 138°38'E; R33782, Punkah Island, Chowilla Stn, 33°57'45"S 140°57'45"E; R37931, Scott's Lagoon, 8.5 km S of Morgan, 34°07'S 139°40'E; R38017, Lake Garnett, 20 km NE of Mannum, 34°53'S 139°31'E.

Other: MNHP 2977 'Nouvelle Hollande' (Syntype of *Lygosoma quoyii*). BMNH 1946.8.4.99, 'Kangaroo Island, S.A.' (in error); 1946.8.15.34–35, 'Queensland'; 1946.8.15.36, 'Australia'; (Types of *Hinulia gastrosticta*). NMW 16656:1–2, 'Kangaroo Island' (in error) (Types of *Hinulia gastrosticta*).

Eulamprus tympanum tympanum.

New South Wales: AMS R111949, Dora Dora National Park proposal area, 35°55'S 147°35'E (Holotype of *Eulamprus herseyi*).

Victoria: NHRM 3094, Neighbourhood of Melbourne (Holotype of *Lygosoma tympanum*). MV D11881–11883, Gellibrand River, 38°31'S 143°32'E; D12207–12216, Gellibrand, 38°31'S 143°32'E; D 13642–13645, Mt. Sabine 38°47'S 147°19'E; D13653–13654, Gellibrand River 38°31'S 143°32'E; D14056–14065, Dellys Dell 37°12'S 142°32'E; D15594, Near Halls Gap, 37°08'S 142°31'E; D17571, Gellibrand River 38°32'S 143°32'E; D33424, Junction of Mairs Track & Syphon Road, 37°11'S 142°20'E; D33491, 3 km S. of Ben Nevis, 37°15'S 143°12'E; D33492–33493, 4.8 km N. of Mt. Cole, 37°17'S 143°16'E; D33500, Grampian Ranges, 37°07'S 142°26'E; D33874, 14.5 km S. of Elmhurst, 37°18'S 143°15'E; D35846, Syphon Road, 37°10'S 142°20'E; D35847, Moora Hut, 34°14'S 142°26'E; D35848–35849, 3.2 km W. of Pirron Yallock, 38°21'S 143°23'E; D3579, Back River Bridge, 8 km W. of Bentleys Plains, 37°14'S 147°49'E; D35794, 12.9 km E. of Moutys Hut; D35795, Ridge over Nuniong Plains, 37°08'S 147°57'E; D35798–800, 3.2 km W. of Cape Horn, 38°44'S 143°34'E; D35802, Great Ocean Road, 3.2 km W. of Apollo Bay, 38°46'S 143°37'E; D 35806, D35808–09, Dargo High Plains, 37°06'S 147°09'E; D35830–33, D35835–39, Lake Mountain road, 6.8 km. from Cumberland road, 37°31'S 145°52'E; D35852–35854, Matlock road, 54.7 km N. of Noojee, 37°24'S 146°0'E; D35855–35856, Matlock road, 37 km N. of Noojee, 37°34'S 146°0'E; D35857, Big River Camp, 37°32'S 145°57'E; D35858–35859, 51.5 km N. of Noojee, 37° 26'S 146° 0'E; D35860–35861, 24 km N. of Noojee, on Matlock Road, 37°41'S 146°0'E; D35862, 66 km N. of Noojee on Frenchmans Spur road, = 29 km E. of Big R. camp,37°32'S 145°57'E; D35863, Wartook, 37°02'S 142°21'E; D35864, 13.7 km N.W. of Peterborough, 38°30'S 142°45'E; D35865, Lake Wartook, 37°05'S 142°27'E; D35866, 4.8 km N. of Tyers, 38°06'S 146°28'E; D35867, 4 km N. of Streiglitz, 37°50'S 144°11'E; D35868, Badger Ck., Healesville, 37°34'S 145°35'E; D35869, Memorial Gardens, Mt. Macedon, 37°22'S 144°35'E; D35870–35871, 8.8 km E. of Marysville, 37°31'S 145° 50'E; D35872, 21 km S.E. of Cumberland Junction 37°42'S 146°04'E; D35881, Fyans Creek, 61 km. N. of Dunkeld, 37°05'S 142°34'E; D35891, Wartook Reservoir, 37°05'S 142°27'E; D35985, Chimney Pot Gap, 37°24'S 142°18'E; D 35985, D35987–90, Chimney Pot Gap, 37°24'S 142°18'E; D35993, Lake Wartook, 37°05'S 142°27'E; D36001, Blanket Bay, 38°49'S 143°35'E; D36002, 8 km N. of Cape Horn, 38°39'S 143°37'E; D36018–36028, 8 km N. of Cape Horn, 38°39'S 143°37'E; D36063–36067, 3.2 km W. of Cape Horn, 38°44'S 143°34'E; D36092–36093, Enfield, 12.8 km S. of Ballarat, 37°45'S 143°47'E; D36173, Lake Wartook, 37°05'S 142°27'E; D36307–36309, Mt. Sabine, 38°38'S 143°44'E; D39399, Mt. William, 37°13'S 144°48'E; D39401–39406, 4 km S. of Ben Nevis fire tower, 37°16'S 143°12'E; D39407, Lake Wartook, Grampian Road 37°05'S 142°27'E; D47759, 4 km W.S.W. of Enfield, 37°45'S 143°45'E; D47760, 3 km W. of Enfield, 37°45'S 143°45'E; D47804–47807, Glenisla Shelter, Victoria Range, 37°09'S 142°15'E; D47808, Mt. William, 37°13'S 144°48'E; D47915, 0.5 km N. of Mt. Langi Ghiran, 37°17'S 143°08'E; D48690, Nowhere Creek, 37°07'S 143°17'E; D48691, Mt. Avoca, 37°06'S 143°21'E; D48709–11, 5 km N.E. of Glenlofty, 37°05'S 143°15'E; D50183–50185, 1 km S. of Mt. Lonarch, 37°16'S 143°21'E; D50257–58, 4 km W. of Mt. Buangor, 37°18'S 143°11'E; D50716–19, Mt. Avoca, 37°06'S 143°21'E; D50951–52, 1 km S.W. of Mt. Sabine, 38°38'S 143°43'E; D50966, Mt. Sabine 38°37'S 143°44'E; D56657, Hopkins Falls, 38°20'S 142°37'E.

South Australia: SAMA R11263, Sect. 123, Hund. of Young, County Grey, 37°43'S 140°45'E; R12400, Southernmost point, Sect. 123, Hund. of Young, County Grey, 37°43'S 140°46'E; R12982, NW of Port Macdonnell, 37°59'S 140°33'E; R13076, SW of Mount Gambier, 37°54'S 140°41'E; R14123, N of Mount Gambier, 37°44'S 140°50'E; R14868, SE of Mount Gambier, 37°55'S 140°57'E; R15163A–B, Sect. 391, Hund. of Caroline, 37°58'S 140°51'E; R16826A–C, Rivoli Bay, 37°32'S 140°06'E; R17889, 5 km N of Wandilo siding, 37°41'S 140°44'E; R19082–83, N of Mount Gambier, 37°42'S 140°46'E; R23890, R23952, Woolwash Creek near Port Macdonnell, 38°03'S 140°45'E; R23926, 10 km NW of Port Macdonnell, 38°00'23"S 140°36'11"E.

E. t. tympanum x marnieae intergrade specimens.

Victoria: D39412, 16 km N. of Camperdown, 38°01'S, 143°09'E; D52910–11, 1.5 km N. of Kariah, 38°10'S, 143°13'E; D56721, 11.5 km NNE of Camperdown, 38°08'S, 143°12'E; D56802, 4.5 km E (100°) of Bookar, Lake Colongulac, 38°10'S, 143°10'E; D56803, 4.6 km ESE (105°) of Cororooke, 38°10'S, 143°32'E; D56804, D56878, 3.4 km SE (130°) E of Cororooke, 38°17'S, 143°33'E.

Eulamprus tympanum marnieae

Victoria: HOLOTYPE: NMV D52921, 5.5 km E. of Dreeite, Victoria, 38°11'S, 143°34'E, P. A. Rawlinson & M. Hutchinson, 1 November, 1979.

PARATYPES: 5.5 km E. of Dreeite: D49377, D49391–92, P. A. Rawlinson & M. Hutchinson, 1 September 1977; D52912–20, D52922–529266, P.A. Rawlinson & M. Hutchinson, 30 October and 1 November, 1979; D62035, M. Hutchinson & S. Donnellan, September, 1986. 5 km E of Dreeite, 38°11'S, 143°34'E, D52955–56, G. Brown, 9 November 1979; D53977–80, G. Brown, 25 January, 1980. Dreeite, Taits Road, 38°11'S, 143°31'E: D49385–87, M. Hutchinson & G. Ingram, 26 August 1977; D49388–90, P. A. Rawlinson & M. Hutchinson, 1 September 1977.

REFERRED SPECIMENS: D36075–84, 8 km S. of Lismore, 38°01'S, 143°20'E, S. Hosgood, 16 April, 1963; D52600–01, Lake Bolac, near caravan park, 37°44'S, 142°52'E, M. Hutchinson & G. Brown, 23 February 1978; D52901–09, Lake Bolac, near caravan park, 37°44'S, 142°52'E, P. A. Rawlinson & M. Hutchinson, 31 October 1979.